Royal Observatory, Edinburgh. Note on the Spectrum of Comet Brooks (1911 *c*). (Plate 1.)

(*Communicated by the Astronomer Royal for Scotland.*)

Photographs of the spectrum of Comet Brooks (1911 *c*) have been obtained on fourteen days between September 1 and October 31, with a prismatic camera, having a lens of Iceland spar, 2 inches aperture and 29 inches focal length, and a quartz prism 60° angle, giving a dispersion between H_β(4861·5) and H_ι(3770·8) of 12·15 mm.

On October 27 and 31 exposures were made with a portrait doublet of 3 inches aperture and 12 inches focal length, with a glass prism of 60° angle, the resulting spectra being the most intense and showing the tail well. The corresponding dispersion was 18·1 mm. between H_β and H_ι; Sirius giving the comparison spectrum.

The plates used were Ilford "Monarch," backed, except on September 8 (Barnet Super-Speed Ortho) and September 21 (Panchromatic), the exposures ranging from 201 minutes to 50 minutes.

As long an exposure as could be obtained was always given, owing to the faintness of the comet, and to its not being very active photographically, and the resulting negatives differ greatly in the amount of detail according to the exposure obtained.

The cameras were rotated so as to have the edge of the prism approximately parallel to the comet's tail, but it was not until the end of October that a definite tail could be traced in the spectra.

With the spar camera no trace could be found of duplicity in the knots, such as is recorded in the spectrum of Comet Morehouse (1908 *c*), the brightest knot λ 467 being, in particular, noted as symmetrical and round. The knot λ 388 was very much flatter, and on one or two negatives gave the impression of a slight shading towards the violet.

With the other camera the knot λ 467 is distinctly double, the fainter image being on the violet side. None of the other knots showed signs of duplicity.

As early as September 8 a faint continuous spectrum could be traced, and this phenomenon was easily visible as the brightness of the comet increased. This comet differs in that respect from Comet Morehouse, in which the continuous spectrum was absent.

The photographs were measured in the Hilger measuring machine—1 revolution of micrometer screw = 1 mm. Except for the two brighter knots λ 388 and λ 457, it was impossible to set the micrometer wire with any degree of accuracy on the knots themselves owing to the magnification (15). In the case of several of them any magnification greater than that given by a hand lens

made them disappear altogether. To remedy this the following device was adopted:—Retouching medium was applied to the film and a fine pencil-mark made at the point desired. The plate was then measured in the direct and reversed positions, and all marks cleaned off with alcohol. After several days the same process was repeated, each marking being made quite independently of the other.

For the two brighter knots the edges were generally well enough defined for measurement, as well as the centre, but the edges of the others were not sharp enough to warrant measurement except at their estimated centre.

A specimen may be given to show the accordance obtained in the measures derived from the marks put upon the images which were too faint for direct measurement. The images in question are the last two of the spectrum in the extreme ultra violet. The two numbers given for each date represent the two independent markings as described above, each separate number being the mean of measures with the plate first direct and then reversed.

	r.	*r.*		*r.*	*r.*
Sept. 8	19·024	26·440	Oct. 6	18·850	
	18·988	26·388		18·835	
20	18·756		10	18·654	26·370
	18·619			18·727	26·269
24	18·930	26·751	26	19·021	
	19·037	26·639		18·909	
27	18·931	26·414	27	18·519	
	18·949	26·441		18·884	
30	18·683	26·094	Means	18·833	26·404
	18·658	26·235			
30	18·785				
	18·910				

In these parts of the spectrum 1^r is equivalent respectively to 48 A.U. and to 36 A.U.

The photographs were all made and measured by Mr. J. Storey.

The determination of the wave-lengths was made as follows. Upon several of the plates taken with the quartz prism, spectra of Vega were also photographed. The best of these was that of September 27 and it was used, to the exclusion of the others. From it, with H_β as origin, measures of the rest of the hydrogen series were taken, and also of the middle of the comet's image at λ 3872. On comparing the measures, expressed in revolutions of the micrometer screw, with the wave-lengths of the hydrogen

lines, it was found that the following formula would represent them all, with errors of very few units in the last place:

$$r = 8{\cdot}709 - 1{\cdot}366\Lambda + 0{\cdot}557\Lambda^2 - {\cdot}00167\Lambda^3,$$

where $\Lambda = \frac{1}{100}$ (wave-length $-$ 4000),

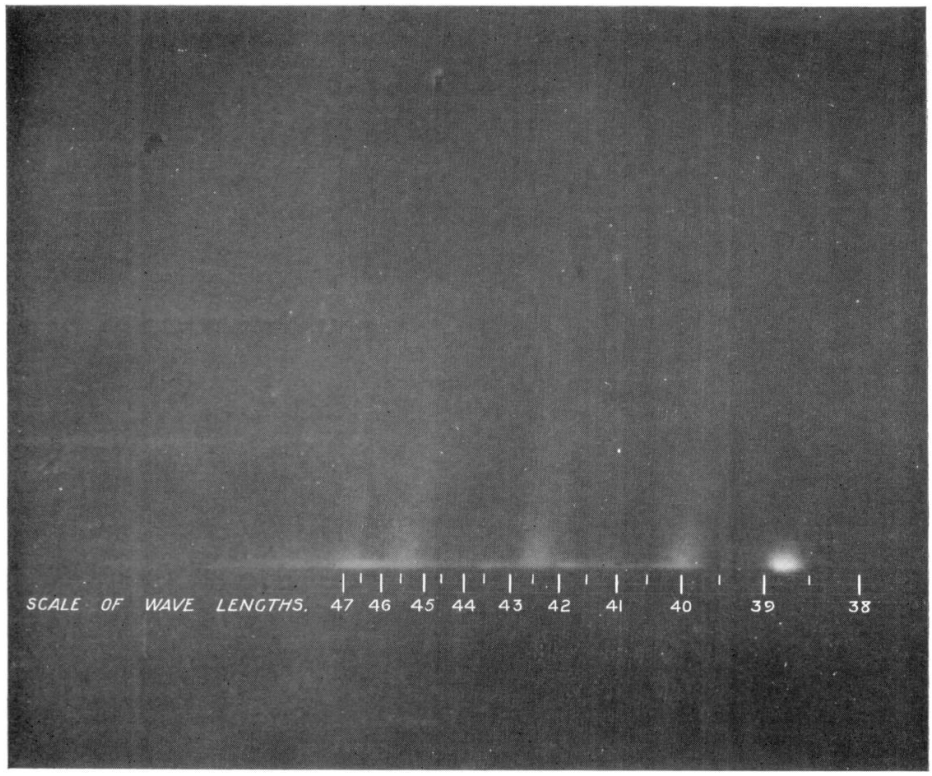
r = revolutions of the screw.

This formula was found by charting the values of r, Λ, and noticing that they nearly followed a parabola with axis parallel to $\Lambda = 0$. The equation of such a parabola can be found, practically exactly, by direct and easy steps, and the small discordances which it leaves point to the value of the fourth term. A small table was then constructed showing the values of r corresponding to values of Λ from -10 upwards. The hydrogen series ends between $\Lambda = -2$ and $\Lambda = -3$; hence for $\Lambda = -9$ and -10, where the last observed image lies, the formula is much less certain than could be wished, but it may be mentioned that it agrees exactly with the result of free-hand continuation of the charted values made before the formula was obtained. The cometary measures on each of the plates were made relatively to that at λ 3872 in terms of revolutions of the screw, and the corresponding wave-lengths read from the table. This applies to the photographs taken with the quartz prism; for those taken with the glass prism the circumstances did not permit a well-placed comparison spectrum of a star to be printed, but one of Sirius was obtained upon the plate, which was measured and compared with the measures of Vega with the quartz prism. The comparison showed that, measuring again from the line H_β as origin, corresponding portions of the spectrum were roughly one-third larger in the former case than in the latter, the ratio increasing towards the violet, or, exactly, that revolutions (r) measured upon the glass-prism plates could be reduced to equivalent measures upon the other plates by multiplying them by the factor

$${\cdot}7637 - {\cdot}00570\, r + {\cdot}000032\, r^2.$$

With the glass prism, the image at λ 3872 appears double; the middle of this double was taken to coincide with the middle of the corresponding images from the quartz prism, and the wave-lengths of the remaining lines deduced, by first converting the relative revolutions of the screw into their equivalent upon the spar plates, and then reading off wave-lengths from the table already employed.

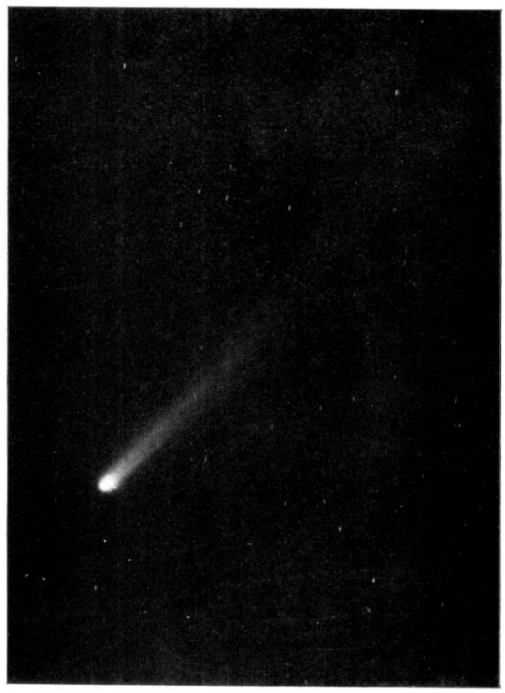
The following are the resultant measures, with estimates of the relative intensities of the condensations, and a few notes added:—



SPECTRUM OF COMET BROOKS (1911 c).

Taken with 3-inch portrait lens and 60° glass prism, 1911 Oct. 27. Exposure 30^{m}.
Enlarged 3·2 times from original negative.

SEPT. 30, $10^{h}\ 12^{m}$—$11^{h}\ 57^{m}$.



OCT. 27, $17^{h}\ 15^{m}$—$17^{h}\ 45^{m}$.

COMET 1911 c (BROOKS).

Taken with 4-inch portrait lens of 33-inches focal length.

The photographs illustrate the change in the type of tail which was noticeable when the Comet reappeared as a morning star.

Quartz Prism.				Glass Prism.			
Wave-length.	Intensity.	Number of Plates where visible.	Notes.	Wave-length.	Intensity.	Number of Plates where visible.	Notes.
5386	2	1					
5024	2	7					
				4841	1	2	Tail only.
4712			Beginning.	4712			Beginning.
4672	12	14	Query tail.	4681	15	2	Head and short tail.
4634			End.	4658			End.
4559	3	3	Faint tail; perhaps head also.	4545	4	2	Strong tail; possibly head.
4353	3	10	No tail.	4358	3	2	No tail.
4251	4	1	Tail only; strongest.	4254	5	2	No head; second strongest tail.
4200	3	8	No tail.	4196	4	2	Head only.
				4114	1	2	Tail just visible.
4022	2	12	Second strongest tail.				
				4006	5	2	Strongest tail.
3889			Beginning.				
3872	20	14	Head; short tail.	3876	20	2	Head strong, double.
3858			End.	3869	14		Perhaps tail.
				3775	1	1	Very faint tail only.
3677	1	1	Very faint tail.				
3580	3	3	Head; fairly strong tail.				
3351	4	10	Head; probably tail also.				
3057	3	5					

A comparison of this spectrum with that of Comet Morehouse (1908 *c*) shows at once that they are almost identical except for the circumstance of the presence of a continuous spectrum in Comet Brooks, and a few other details. Taking the comparison from the paper by MM. de la Baume Pluvinel and Baldet in *Astrophysical Journal*, 1911 September, the line 5386 may possibly be the same as the unidentified 5369 given by these authors, the extrapolation making in our case the measure somewhat uncertain. 5024 corresponds with their 5021, which they attribute to CO, though it is among the cases where their numbers are a little discordant from Fowler's. The image of the tail at 4841 agrees with their 4846, which is also apparently a discrepant member of the CO series, but yet a case in which they feel able to insist

upon their number. Next is a hydrocarbon band. M. Bosler, in *Comptes Rendus*, 1911 October 23, remarks that this band extends into the tail about 30′: "alors que le spectre des hydrocarbures et celui du cyanogène sont pour ainsi dire limités à la tête." The images of the tail at 4559, 4545 are due to CO. The images of the head at 4353, 4358 seem due to carbon, which was represented in Comet Morehouse by a faint image at 4372. The measures 4251, 4254 belonging to the tail only are due to CO. 4200, 4196, belonging to the head only, as well as the group with middle at 3872, are due to CN. In the spectrum given by the glass prism, this shows neatly double. The images of the tail at 4022, 4006 represent another image of the CO series. The image of the tail at 3775 seems to represent the CO pair that in Comet Morehouse was found at 3783 and 3803. The image at 3677 is very faint, but seems to represent the CO pair 3687, 3701. There remain the images of the tail at 4114, and the two images of the head shown by the quartz prism deep in the ultra violet, measured at 3351 and 3057. These last are extrapolated so far beyond the point where the hydrogen series ceases that it is impossible to insist closely upon the numbers. Still it is evident, from plotting the measured portion upon a chart, that they cannot be far wrong, unless the character of the dispersion by the quartz suffers a great and rapid change in this portion of the ultra violet. As far as appears, they do not seem to have been observed before.

Royal Observatory, Edinburgh. Astrographic Measures of Double Stars (Zone − 40°). By R. W. Wrigley, B.A., F.R.S.E.

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The following is a list of the double stars measured on the plates comprising zone − 40° of the Astrographic Catalogue, and therefore includes stars between the parallels of declination 39° and 41° south. The plates were taken at the Perth Observatory (Western Australia), mainly in 1903–4, and the measures have been made at the Royal Observatory, Edinburgh. The distance and position angle for each pair of stars have been obtained from the ordinary rectangular co-ordinates by a method similar to that described by Mr. H. C. Plummer (*Monthly Notices*, lxix. 2). If (x, y), $(x+\delta x, y+\delta y)$ represent the standard co-ordinates of any pair of stars referred to a corner of the plate as origin, then according to the notation used for this zone—

$$\text{Distance between the stars} = \left\{ (\delta x)^2 + (\delta y)^2 \right\}^{\frac{1}{2}} \times 300''$$

$$\text{Position angle in degrees} = \tan^{-1}\frac{\delta x}{\delta y} + 1^\circ(x - 14)\tan(\text{dec.}) \div 12$$

As might have been expected, very few pairs closer than 3″